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Maximization of the lift/drag ratio of airfoils with a turbulent boundary layer: Sharp estimates, approximation, and numerical solutions

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Abstract

The lift/drag ratio of an airfoil placed in an incompressible attached flow is maximized taking into account the viscosity in the boundary-layer approximation. An exact solution is constructed. The situation when the resulting solutions are not in the admissible class of univalent flows is discussed. A procedure is proposed for determining physically feasible airfoils (with a univalent flow region) with a high lift/drag ratio. For this purpose, a class of airfoils is constructed that are determined by a twoparameter function approximating the found exact solution to the variational problem. For this class, the ranges of free parameters leading to physically feasible flows are found. The results are verified by computing a turbulent boundary layer using Eppler's method, and airfoils with a high lift/drag ratio in an attached flow are detected. © 2009 Pleiades Publishing, Ltd.

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Keywords

Aerohydrodynamics, Airfoil optimization, Ideal incompressible fluid model, Theory of analytic functions, Variational inverse boundary value problems in aerohydrodynamics